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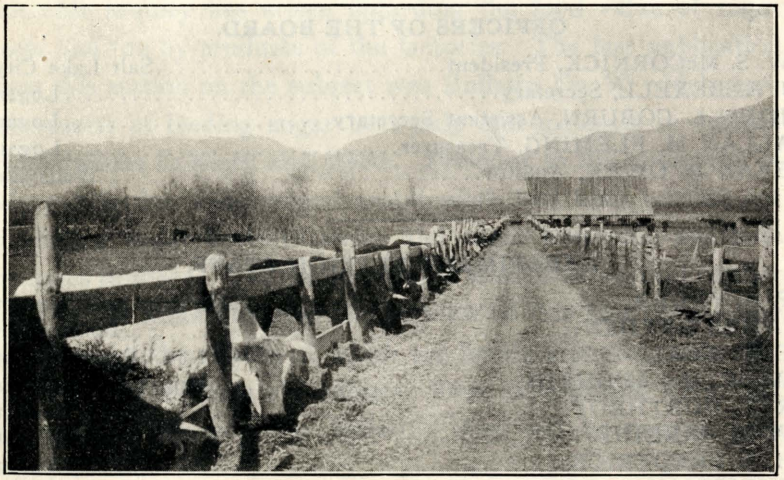
OF UTAH

Bulletin No. 101



STEERS FEEDING ON SUGAR BEET PULP.

FEEDING EXPERIMENTS WITH CATTLE, SHEEP, SWINE AND HORSES

DECEMBER, 1906, LOGAN, UTAH

TRIBUNE-REPORTER PRINTING CO.
SALT LAKE CITY, UTAH

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FEEDING EXPERIMENTS WITH CATTLE, SHEEP, SWINE AND HORSES

By R. W. Clark.

INTRODUCTION.

Since the establishment of sugar factories in this State, considerable inquiry has arisen regarding the food value of sugar beets and the by-products of the factories. The last publication from this station on the subject was Bulletin No. 90 which gave the results of feeding sugar beet pulp and molasses in various combinations to sheep and steers. Previous to the appearing of this publication some experimental work had been carried out in feeding sugar beets to swine and sugar beet pulp and beet molasses to sheep. The results secured seemed to warrant further work in the same direction and in view of this fact the feeding experiments, the results of which are herein reported, were carried out. As methods of feeding in these experiments were fully discussed in the previous bulletins they will be treated very briefly in this.

In all of this work the preliminary feeding periods consisted of seven to fourteen days, the longest period being with cattle. The animals were weighed for two or more consecutive days at the beginning and at the close of each feeding period and the average weight determined. They were divided as nearly as could be into groups of equal merit. All of the feeding experiments with dairy cows, except one, were divided into two periods and the feed of each lot was reversed at the close of the first period. By this method individuality was overcome and better results secured. The length of the periods varied with the different classes of animals.

The prices of foods, according to the markets, are as follows:

Alfalfa	$ 5.00 per ton
Bran	16.00 per ton
Shorts	20.00 per ton
Sugar beets	4.50 per ton
Beet molasses	3.00 per ton
Beet pulp	1.00 per ton
Skim milk	15 cents per cwt.

Plan of Work.

*The results of the following lines of work are reported in this bulletin:

PART I.

I. Feeding sugar beets and sugar beet pulp to dairy cows.
II. Feeding sugar beets and pulp to sheep and steers.
III. Feeding sugar beets, sugar beet pulp and beet molasses to swine.
IV. Feeding sugar beet pulp to horses.
V. Effect of beet pulp on strength of bone.

PART II.

I. Feeding different amounts of grain to dairy cows.
II. Apples as a food for swine.
III. Grazing experiment with swine.
IV. Cost of growing swine.
V. Cost of raising cattle to two years of age.
VI. Profit in running sheep on enclosed farm.

*Owing to the work in feeding beet tops to dairy cows being incomplete, consisting of only one year, the results are not reported.

PART I.

Feeding Sugar Beets to Dairy Cows.

In feeding sugar beets to cows, the amount first given was small and was gradually increased until 30 to 40 pounds were consumed in two feeds per animal per day. The cows weighed about 1,100 pounds each. In the first experiment in sugar beet feeding, cows weighing 750 pounds and receiving the above amount of beets, scoured, which was thought to be due to too many beets. The beets, which were sliced, were always readily consumed and apparently relished. The cows were not far advanced in lactation when the experiment began, the aim being to have them in a good flow of milk during the experiment. Care was taken to avoid such conditions as would affect the milk flow.

Table I gives the results by years, separately and combined.

From the combined results of the two years it is seen that the lot getting beets made butter fat at a cost of 18.9 cents per pound, while the lot that got no beets made butter fat for 12.8 cents per pound. The former lot produced more milk and butter fat but at a considerably higher cost. The animals receiving beets made a greater increase in live weight but not enough to be of any significance when the number of animals and periods are considered. If the difference in gains of the two lots is disregarded and a value of $1.00 per ton given to sugar beets, then the cost of a pound of butter fat from each lot would be the same. Fifteen thousand seven hundred and thirty-eight pounds of beets saved 1,877 pounds of alfalfa hay and 23 pounds of grain, and produced 257 pounds of milk. If alfalfa hay has a value of $5.00 per ton, and grain $16.00 per ton, and milk a value of $1.00 per cwt., sugar beets would have a value of 94 cents per ton. A feed of sugar beets produced milk a trifle higher in butter fat than a feed without sugar beets.

In order to ascertain whether or not the milk flow and fat produced were maintained as well with beets as without them, a comparison of the performance of four cows was made between the first and ninth weeks. The animals of each lot were considered of equal merit so far as milk flow, period of lactation, etc., were concerned. The lot getting beets produced 20.2 pounds of

RESULTS OF FEEDING SUGAR BEETS TO DAIRY COWS.

Winter 1903 and 1904.

TABLE I.

Lot	No. of Periods	Gain in Live Weight Per Lot, Pounds	No. Days in Period	Total Milk Produced Pounds	Total Fat Produced Pounds	Milk Produced Per Animal Per Day, Pounds	Fat Produced Per Animal Per Day, Pounds	Per Cent Fat in Milk	Cost of Butter Fat Per Pound, Cents	Cost of 100 Pounds Milk Cents	Total Food Consumed, Pounds			Lbs. Food Required for 100 Lbs. Milk			Lbs. Food Consumed Per Animal Per Day			Average Weight of Animals
											Alfalfa	Grain	Sugar Beets	Alfalfa	Grain	Sugar Beets	Alfalfa	Grain	Sugar Beets	
Beets ...	2	* 43	24	2,828	124.7	19.6	.86	4.46	17.6	77	2,556	821	4,008	90	29	141	18.	5.7	27.8	1,049
No Beets	2	*125	24	2,676	114.1	18.6	.77	4.36	12.8	54	3,184	844	.....	119	31	...	22.1	5.8	....	984

Winter of 1904 and 1905.

Beets ...	3	*216	*1–28 2–42	7,880	311.67	23.4	.92	3.98	19.7	78	7,626	2,016	11,730	96	25	149	23.	6.	35.	1,140
No Beets	3	* 63	*1–28 2–42	7,775	298.3	23.1	.88	3.90	12.8	48	8,875	2,016	.....	114	25	...	26.	6.	....	1,137

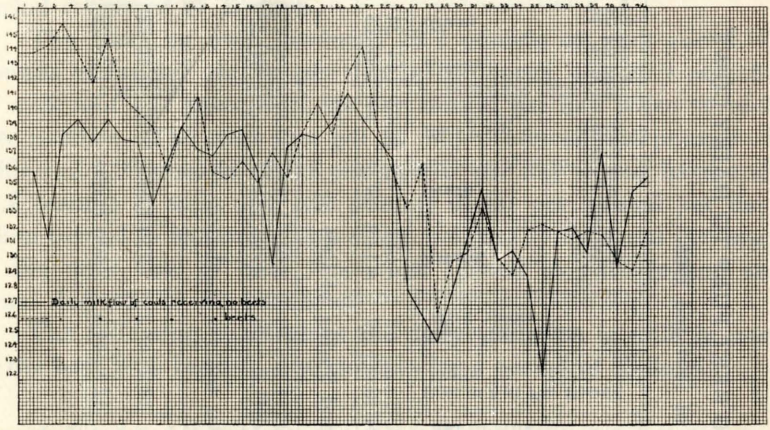
Above results of two years combined.

Beets ...	5	*259	*2–24 2–42 1–28	10,708	436.37	22.3	.91	....	18.9	77	10,182	2,837	15,738	95	26	147	21.	5.9	33.	1,094
No Beets	5	*188	*2–24 2–42 1–28	10,451	412.4	21.8	.82	....	12.8	50	12,059	2,860	.....	115	27	...	25.	5.9	....	1,060

*Number of periods, with number of days in each.

milk and .9 pounds of fat per animal per day the first week; 18.8 pounds of milk and .86 pounds of fat per animal per day the ninth week. The lot that got no beets produced 23.3 pounds of milk and .82 pounds of fat per day the first week and 22 pounds of milk and .84 pounds of fat per day the ninth week.

The following chart shows the daily variation in milk flow of the two lots for one experiment of 42 days.



————Daily milk flow of cows receiving no beets.
- - - Daily milk flow of cows receiving beets.

Feeding Beet Pulp to Dairy Cows.

Beet pulp was fed to cows in the same manner as were sugar beets, but with much more difficulty. Some of the animals seemed to relish it while others took to it somewhat reluctantly.

Table II gives the results of this work.

Putting a value of $1.00 per ton on pulp in the combined results, the animals getting it made butter fat at a cost of 12.9 cents per pound while the cows getting no pulp made fat for 12.3 cents per pound. The cows on pulp made 64 pounds more of milk and an increase of 117 pounds in live weight over the cows without pulp, but consumed 200 pounds less of alfalfa hay. If the same method of calculation and prices are used as when sugar beets were fed, beet pulp would have a value of 90 cents per ton. Milk

RESULTS OF FEEDING BEET PULP TO DAIRY COWS.

Winter of 1904 and 1905.

TABLE II.

Lot	No. of Periods	Loss or (*) Gain Per Lot, Pounds	No. of Days in Period	Total Milk Produced Pounds	Total Fat Produced Pounds	Milk Produced Per Animal Per Day, Pounds	Fat Produced Per Animal Per Day, Pounds	Average Per Cent Fat in Milk	Cost of Fat Per Pound Cents	Cost of 100 Pounds Milk, Cents	Total Food Consumed, Pounds			Food Required for 100 Lbs. Milk, Pounds			Food Consumed Per Animal Per Day, Pounds			Average Weight of Animals
											Alfalfa	Grain	Beet Pulp	Alfalfa	Grain	Beet Pulp	Alfalfa	Grain	Beet Pulp	
Pulp	2	* 27	28	2,826	119.4	17	.71	4.25	15.2	65	4,089	672	5,348	144	24	189	24	4	32	1,117
No Pulp.	2	79	28	2,644	115.0	16	.68	4.24	13.6	59	4,143	672	.....	156	25	...	24	4	..	1,085
Winter and Spring of 1904.																				
Pulp	2	* 91	24	4,752	168.4	33	1.17	3.68	11.2	40	3,647	1,008	3,669	76	21	77	25	4	25	1,051
No Pulp..	2	* 80	24	4,471	156.0	31	1.08	3.66	11.2	39	3,793	1,008	.....	84	22	...	26	7	..	1,037
Above results of two winters combined.																				
Pulp	4	*118	*2-28 2-24	7,578	287.8	24	.92	....	12.9	49.2	7,736	1,680	9,017	102	22	118	25	5.3	28	1,084
No Pulp..	4	*1	*2-28 2-24	7,514	270.3	24	.86	....	12.3	44.0	7,936	1,680	.....	105	22	...	25	5.3	..	1,061

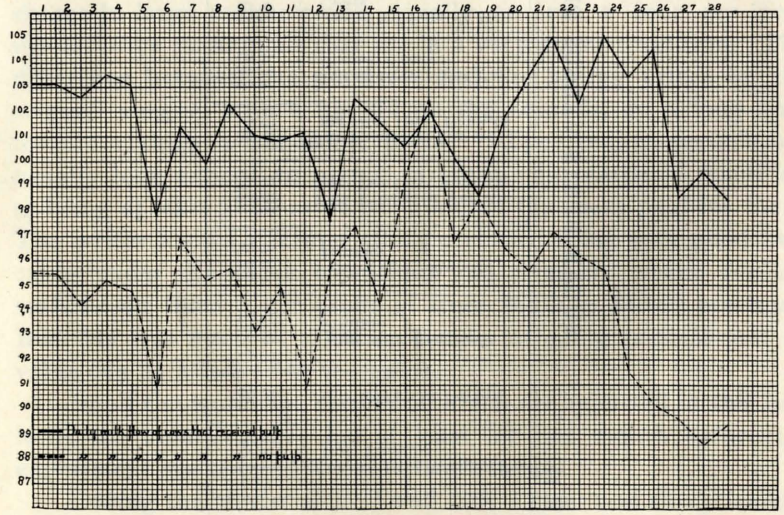
*Number of periods, with days in each.

from pulp-fed cows contained a higher per cent of fat than milk from cows which had not been fed pulp.

As the feeding period proper consisted of only 28 days, a comparison of the performance between the first and last weeks of pulp feeding is not made as in sugar beet feeding, but instead a comparison of the performance of both lots while on pulp and on pasture, the pulp being left out of the ration on pasture and a preliminary period of thirteen days intervening. The pasture period consisted of 21 days.

The cows on pulp produced 28.2 pounds of milk and 1.17 pounds of fat per animal per day in the barns, and 29.9 pounds of milk and 1.11 pounds of fat per animal per day when turned into pasture. The cows that got no pulp produced 26.6 pounds of milk and 1.08 pounds of fat per animal per day in the barn and 28.2 pounds of milk and 1.02 pounds of fat per animal per day when turned to pasture. There was practically an equal increase in the milk flow of both lots when turned to pasture and an equal decrease of fat produced.

The following chart gives the daily variation in milk in one of the beet pulp feeding experiments for a period of 28 days.



————Daily milk flow of cows that received pulp.
- - - Daily milk flow of cows that received no pulp.

SUGAR BEETS VERSUS BEET PULP FOR DAIRY COWS.

TABLE III.

Lot	Loss in Live Weight Per Lot, Pounds	No. of Days in Period	Total Milk Produced Pounds	Total Fat Produced Pounds	Milk Produced Per Animal Per Day, Pounds	Fat Produced Per Animal Per Day, Pounds	Cost of Butter Fat Per Pound, Cents	Cost of 100 Pounds Milk Cents	Total Food Consumed Pounds				Food Required for 100 Pounds of Milk Pounds				Food Consumed Per Animal Per Day Pounds			
									Alfalfa	Grain	Sugar Beets	Beet Pulp	Alfalfa	Grain	Sugar Beets	Beet Pulp	Alfalfa	Grain	Sugar Beets	Beet Pulp
Beets ..	—140	28	1,677	76.6	19.9	.91	17.4	79	1,607	485	2,424	....	95	29	144	...	19.1	5.7	29	..
Pulp ...	—124	28	1,877	72.9	22.3	.86	14.5	50	1,831	504	.....	2,027	97	26	...	108	21.8	6.0	..	24

Sugar Beets Versus Beet Pulp for Dairy Cows.

In this experiment the intention was to feed beets to one lot of cows and pulp to the other and to reverse the feed on them as in the experiments at the close of the first period, but as the cows that had been on beets would not take pulp, the experiment closed necessarily at the end of the first period.

Table III gives the results of the trial.

In this trial the cost of one pound of butter fat from the beet and the pulp lots was 17.4 cents and 14.5 cents respectively. The cost per hundred of milk was 79 cents on beets and 50 cents on pulp. The loss in live weight was considerable in both lots and this taken into account, the cost of production would be increased. As this trial consisted of a single feeding period there are no conclusions drawn.

Feeding Sugar Beets and Sugar Beet Pulp to Sheep and Steers.

In all this experimental work on meat production, profit from the standpoint of the feeder is probably not considered as it should be, but this is mainly due to the small number of animals with which we have been compelled to work. The feeder purchases in large numbers and usually secures a four per cent shrink, often on animals that are in a very gaunt condition. The difference between the purchase and the selling prices on the original weight, with a big fill on the animals, go a long way toward making a handsome profit. The feeding periods are usually long enough to permit of getting the cattle in condition to bring at least $1.50 more per hundred than was paid for them. The writer knows a farmer who purchased some very good beef cattle under the above conditions and after six weeks' feeding realized on them a net profit of from $8.00 to $10.00 per head. But this was more of a filling than a fattening process and no value can be attached to the gains.

In all the work, the results of which are reported in this bulletin, the animals were fed at least for one month before the experiment started and the results are actual.

During the winter of 1903 and 1904 a steer and sheep feeding experiment was carried on in co-operation with Mr. Lars Hansen, a practical feeder at the Logan sugar factory. The experiment

FEEDING BEET PULP WITH ALFALFA WITH AND WITHOUT GRAIN TO SHEEP AND STEERS.

Steers.

TABLE IV.

LOT	Average Weight at Beginning of Experiment.	Average Weight at Close of Experiment.	Average Gain per Head per Day—Pounds.	Cost of Gain per 100 Pounds.	Total Food Consumed—Pounds.			Food Consumed per Pound of Gain—Pounds.			Food Consumed per Animal per Day—Pounds.		
					Alfalfa.	Beet Pulp.	Grain.	Alfalfa.	Beet Pulp.	Grain.	Alfalfa.	Beet Pulp.	Grain.
I.													
Alfalfa, ad lib.....													
Pulp, ad lib.....	913	1,009	1.37	$7.31	6,020	40,425	.....	12.5	83.8	.....	17.2	115	
II.													
Alfalfa, ad lib.....													
Pulp, ad lib.....													
Grain, 4 lb. p. head p. day.	914	1,059	2.06	5.77	4,810	37,575	1,400	6.6	51.6	1.92	13.7	107	4.0
III.													
Alfalfa, ad lib.....													
Pulp, ½ as much as Lot I.	949	1,089	2.00	4.14	7,580	20,300	.....	10.8	28.9	.....	21.7	58	
IV.													
Alfalfa, ad lib.....													
Pulp, ¼ as much as Lot I.	937	1,077	2.00	3.83	8,745	10,205	.....	12.4	14.5	.....	24.9	29.1	.....
V.													
Pulp, ad lib.....													
Alfalfa, ½ as much as Lot I	892	996	1.48	6.11	3,183	47,750	.....	6.12	91.8	.....	9.0	136.4	.....

Sheep.

I.													
Alfalfa, ad lib.....													
Pulp, ad lib.....													
Grain, 1 lb. p. head p. day.	79	101	.31	5.15	1,907	7,716	1,050	5.7	23.3	3.2	1.8	7.3	1.00
II.													
Alfalfa, ad lib.....													
Pulp, ad lib.....													
Grain, ½lb. p. head p. day.	74.5	94.7	.20	4.47	2,026	8,320	525	6.7	27.7	1.75	1.9	7.9	.50
III.													
Alfalfa, ad lib.....													
Pulp, ad lib.....	74.6	91.4	.20	4.05	2,154	9,685	.....	8.5	38.4	.....	2.0	9.2	.....
IV.													
Alfalfa, ad lib.....													
Pulp, ½ as much as Lot III	67.5	86.2	.26	3.18	2,623	4,824	.....	9.3	17.1	.....	2.5	4.6	.....
V.													
Alfalfa, ad lib.....													
Pulp, ¼ as much as Lot III	67.2	84.3	.26	3.25	3,181	2,472	.....	11.2	8.7	.....	3.0	2.6	.....
VI.													
Pulp, ad lib.....													
Alf., ½ as much as Lot III	73.7	90.1	.23	3.59	1,156	11,960	.....	4.6	48.4	.....	1.1	11.3	.....

was to run 120 days, but owing to the very bad weather and other unavoidable conditions, it closed at the end of 70 days. The animals here, as in other experiments, were weighed for three consecutive days at the beginning and at the close of the experiment. The sheep were yearling, grade Cotswold wethers, the steers were two-year-old grade Shorthorns. The former were divided into lots of fifteen each and the latter into lots of five each. The feeding was done in the open and at times the yards were very muddy, which, of course, was detrimental to good growth.

Table IV gives the results of this test with steers.

The steers in Lot I that received all the alfalfa and beet pulp they would take made 1.37 pounds gain per head per day and for 1 pound gain required 12.5 pounds of alfalfa hay and 83.8 pounds of pulp; while the steers in Lot II that received the same, with the exception of 4 pounds of grain per head additional, made 2 pounds gain per head per day and for one pound gain required 6.6 pounds alfalfa, 51.6 pounds beet pulp and 1.92 pounds grain. The addition of 4 pounds grain per day reduced the cost of 100 pounds gain from $7.31 to $5.77. By reducing the pulp on Lot III to 58 pounds per animal per day, 10.8 pounds alfalfa and 28.9 pounds pulp were required for 1 pound gain and the cost per hundred was reduced to $4.14, while the gain per day remained the same as in Lot II. The steers in Lot IV, on which the pulp was further reduced, made a daily gain of 2 pounds per day and 1 pound gain required 12.4 pounds alfalfa and 14.5 pounds pulp. The cost per 100 pounds was $3.83. The steers in Lot V that received all the pulp they would take, and were limited to one-half the alfalfa they would take, made a daily gain of 1.5 pounds each and 1 pound gain required 6.12 pounds alfalfa and 91.8 pounds pulp. One hundred pounds increase cost $6.11.

These results indicate that by adding 4 pounds grain to a ration of alfalfa and beet pulp for steers, larger and more economical gains will be secured; further, that by limiting the amount of pulp fed in a ration of alfalfa and pulp more economical gains will be secured and that in feeding all the pulp that will be taken, limiting the alfalfa, reduces the daily gain and increases the cost.

The sheep in Lot III that received all the alfalfa and beet pulp that they would take, made .2 pounds' gain per head per

day; and for 1 pound gain took 8.5 pounds alfalfa and 38.4 pounds pulp. The sheep in Lot I that got all the alfalfa and beet pulp they would take and 1 pound grain per head per day, made .31 pounds' gain per day; and for 1 pound gain took 5.7 pounds alfalfa, 23.3 pounds pulp, and 3.2 pounds grain. The lambs that got 1 pound grain per head per day made 100 pounds' gain for $5.15 and those that got no grain made it for $4.05. The lambs which got one-half pound grain per head per day took more alfalfa and pulp for 1 pound gain than did those that got twice as much grain and the cost of increase per hundred was reduced 68 cents. By reducing the pulp on Lots IV and V, as compared with Lot III, the gains were slightly increased and the cost per hundred of increase lessened. By increasing the pulp and decreasing the amount of alfalfa fed, the cost of production was slightly increased as compared with Lots III and IV on which the pulp was limited, but this reduced the cost of production as compared with animals in Lot II which were allowed all the alfalfa and pulp they would take.

Feeding Sugar Beets to Steers and Sheep.

During the winter of 1905 and 1906, an experiment was carried on to determine the value of sugar beets for making beef and mutton when fed in connection with grain (⅔ bran and ⅓ shorts) and alfalfa. There were nine two-year-old grade Shorthorn steers and twenty-two grade Dorset lambs. The steers were divided into two lots, one of four steers and the other of five; and the sheep into two lots of eleven each. There were several weeks of preliminary feeding and the weights at the beginning and close of the experiment are the average of several consecutive days. At the end of the first period the feed was reversed on the sheep. Table V gives the results of this test.

The steers on beets made a daily gain of 1.56 pounds, while those that got no beets made a daily gain of 1.13 pounds. With the former, 1 pound of gain cost 9.6 cents, and with the latter 7.3 cents. In the production of 1 pound gain, 21.1 pounds beets saved 1 pound of grain and 6.8 pounds alfalfa hay. According to these results if grain is worth $16 and alfalfa hay $5 per ton, beets would have a value of $2.36 per ton.

TABLE V.

LOT	Average Weight at Beginning of Experiment—Pounds.	Average Weight at Close of Experiment—Pounds	Gain per Animal per Day—Pounds.	Cost of Gain per 100 Pounds.	Number of Days in Experiment.	Number of Animals in Lot.	Total Food Consumed—Pounds.			Food Consumed per Animal per Day—Pounds.			Food Consumed per Pound of Gain—Pounds.		
							Alfalfa.	Grain.	Sugar Beets.	Alfalfa.	Grain.	Sugar Beets.	Alfalfa.	Grain.	Sugar Beets.
Beets	3,769.5	4,393.5	1.56	$9.60	100	4	7,085	1,600	13,215	12.7	4	33	11.3	2.5	21.1
No Beets	4,833	5,398	1.13	7.30	100	5	10,229	2,000	.....	20.4	4	.....	18.1	3.5	.....
Sheep, 1st Period.															
Beets	946	1,275	.35	6.28	85	11	1,619	467.5	5,720	1.7	.5	6.1	4.9	1.4	17.3
No Beets	909	1,116	.22	5.39	85	11	2,968	467.5	.....	3.2	.5	.....	14.3	2.2	.....
Sheep, 2nd Period.															
Beets	.....	.....	.34	7.49	62	10.48	1,395	325	4,650	2.1	.5	7.1	6.3	1.47	21.0
No Beets	.....	.....	.21	6.08	62	11	2,281	341	.....	3.3	.5	.....	17.4	2.45	.....

TABLE VI.

Results of Feeding Sugar Beet Molasses to Pigs.

LOT	Average Weight at Beginning of Experiment—Pounds.	Average Weight at Close of Experiment—Pounds	Average Gain per Pig per Day—Pounds.	Cost of 100 Pounds Gain.	Total Food Consumed Pounds.				Food Consumed per Pound of Gain—Pounds.				Food Consumed per Animal per Day—Pounds.			
					Green Alfalfa.	Skim Milk.	Shorts.	Molasses	Green Alfalfa.	Skim Milk.	Shorts.	Molasses.	Green Alfalfa.	Skim Milk.	Shorts.	Molasses.
Molasses ...	.39.1	99.2	1.03	$2.43	102	870	552	150.5	.4	3.7	2.4	.64	.44	3.7	2.3	.64
No Molasses	37.8	87.5	.85	2.92	127.5	1072	698.5		.4	3.7	2.4		.44	3.7	2.3	

With sheep, as with steers, market prices being used, cheaper gain was made without beets than with them. In the first feeding period, in the production of 1 pound gain, 17.3 pounds beets saved .8 pound grain and 9.4 pounds alfalfa hay. This would give beets a value of $3.45 per ton. In the second feeding period in the production of 1 pound gain, 21 pounds beets saved .98 pounds grain and 11.1 pounds alfalfa hay, and the beets would have a value of $3.38 per ton.

Feeding Sugar Beet Molasses to Pigs.

In the summer and fall of 1903, a feeding trial of 58 days was carried on to determine the value of sugar beet molasses as a food for pigs. There were five pigs in one lot and four in the other. Table VI gives the results of this trial.

Sixty-four one-hundredths of a pound of molasses produced .18 pound of pork. According to these figures pork selling at $4 per hundred, and foods at market prices, molasses would have a value of $1.12 per cwt. The pigs on molasses made a gain for $2.43 per hundred and the pigs that received no molasses made it for $2.92 per hundred. The molasses was mixed with the grain and whenever too much was fed the pigs scoured.

In the fall of 1904 a feeding trial of 48 days was made with shotes, in which the following rations were used: Shorts; shorts and beet pulp; shorts and sugar beets; shorts, beet pulp and sugar beet molasses. Well bred shotes were used which at 5½ months of age, when the trial began, weighed 130 pounds each.

Table VII gives the results of this experiment.

Two and eighty-one hundredths pounds of beet molasses fed with shorts, gave an increased growth of .36 pound and saved 4.3 pounds of beet pulp and .9 pound of shorts. Pork selling at 4 cents per pound and beet pulp and shorts at $1.00 and $16.00 per ton respectively, beet molasses would have a value of 84 cents per 100 pounds. Combining these results with the results in Table VI, and averaging them, molasses would have a value of 98 cents per cwt.

In this trial the pigs that were on shorts as a single diet required 4.4 pounds for 1 pound gain, while the pigs that got beet pulp required 2¾ pounds of shorts and 10.3 pounds pulp for 1

TABLE VII.

LOT	Average Weight at Beginning of Experiment—Pounds.	Average Weight at Close of Experiment—Pounds.	Average Gain per Shote per Day—Pounds.	Cost of 1 Pound Gain—Cents.	Total Food Consumed—Pounds.				Food Consumed per Pound of Gain—Pounds.				Pounds of Food Consumed per Animal per Day.			
					Shorts.	Beet Pulp.	Sugar Beets.	Beet Molasses.	Shorts.	Beet Pulp.	Sugar Beets.	Beet Molasses.	Shorts.	Beet Pulp	Sugar Beets	Beet Molasses.
Shorts	133	216	1.73	$3.55	1108				4.44				7.6			
Shorts and Beet Pulp	130	187	1.2	2.70	473	1771			2.75	10.3			3.28	12.3		
Shorts and Sugar Beets	130	187	1.2	3.71	463		1199		2.68		6.97		3.21		8.3	
Shorts, Pulp and Molasses	139	214	1.56	2.21	418	1354		634	1.86	6.0		2.81	2.97	9.4		4.4

TABLE VIII.

LOT	Average Weight at Beginning of Experiment—Pounds.	Average Weight at Close of Experiment—Pounds.	Average Gain per Animal per Day—Pounds.	Cost of Gain per Pound—Cents.	Total Food Consumed—Pounds.				Food Consumed per Pound of Gain—Pounds.				Food Consumed per Animal per Day—Pounds.			
					Shorts	Beet Pulp.	Sugar Beets.	Skim Milk.	Shorts.	Beet Pulp.	Sugar Beets.	Skim Milk.	Shorts.	Beet Pulp.	Sugar Beets.	Skim Milk.
Shorts and Skim Milk.....	112	175	1.36	$3.62	935			560	4.07			2.4	5.5			3.3
Shorts, Skim Milk and Beet Pulp..	112	172	1.07	3.38	606	874		560	3.34	4.82		3.09	3.6	5.2		3.3
Shorts, Skim Milk and Sugar Beets	116	192.1	1.13	3.93	606		797	560	3.18		4.2	2.94	3.6		4.7	3.3

pound gain. Ten pounds beet pulp saved 1.7 pounds shorts, and if pork is worth 4 cents per pound the pulp would have a value of $2.72 per ton. Six and ninety-seven hundredths pounds sugar beets saved 1.76 pounds of shorts. If the same method of calculation is used as in case of pulp feeding, sugar beets would have a value per ton of $4.04. The largest daily gain was made on shorts and the second largest on shorts, beet pulp and beet molasses. Equal gains were made on sugar beets and beet pulp.

Beet molasses should be fed carefully as too much will cause scouring.

The pork from the pigs in this trial was sold in the vicinity of the Experiment Station and all except that from the molasses-fed pigs was pronounced fine in every respect. The pork produced on molasses was objected to on the ground that it had a peculiar unsavory taste.

In the fall and winter of 1903 an experiment was carried on with swine to determine the value of sugar beets and sugar beet pulp. Table VIII gives the results.

According to the above table, 2.4 pounds skim milk and 4.07 pounds shorts produced 1 pound gain, while with beet pulp 3.09 pounds skim milk, 3.34 pounds shorts and 4.82 pounds of pulp were required for 1 pound gain. Four and eighty-two hundredths pounds pulp and .69 pound skim milk saved .73 pounds shorts. Valuing the skim milk at 15 cents per hundred and the shorts at $16.00 per ton and subtracting the value of the skim milk from the value of the shorts, the difference then in shorts saved would be due to pulp and the latter would have a value per ton of $2.42. These results combined with those in Table VII give pulp an average value of $2.57 per ton, as a pork producer.

Four and two-tenths pounds sugar beets and .54 pound of skim milk saved .89 pound shorts. Calculating the results the same as in pulp feeding, would give beets a value of $3.00 per ton. Combining the results with those of Table VII gives sugar beets an average value of $3.52 per ton as a food for swine as against $2.57 per ton for pulp.

During the summer of 1904 an experiment was conducted with pigs on alfalfa pasture with shorts in various proportions, with and without beet molasses and skim milk. The pigs were about eleven weeks old when the experiment began and there

TABLE IX.

LOT	Average Weight at Beginning of Experiment—Pounds.	Average Weight at Close of Experiment—Pounds.	Average Gain per Pig per Day—Pounds.	Total Gain—Pounds.	Cost of Gain—Per Cent.	Total Food Consumed—Pounds				Food Consumed per Pound Gain—Pounds				Food Consumed per Pig per Day—Pounds.			
						Shorts.	Alfalfa Pasture.	Molasses.	Skim Milk.	Shorts.	Alfalfa Pasture.	Molasses.	Skim Milk.	Shorts.	Alfalfa Pasture.	Molasses.	Skim Milk.
I. Shorts, Alfalfa Pasture	49.6	78	.5	170	$4.99	819	5604			4.8	3.3			2.4	16.6		
II. Shorts, Alfalfa Pasture, Molasses	40.5	88	.72	243.5	3.18	478	9716	395		1.9	3.9	1.62		1.42	28.9	1.1	
III. Shorts, Alfalfa Pasture, Molasses, Skim Milk	56	119.4	1.13	380.5	2.78	489	9356	349	1956	1.28	2.45	.91	5.1	1.45	27.8	1.0	5.8
IV. ½ Shorts, Alfalfa Pasture, Skim Milk, Molasses	49.5	105.5	1.00	336	2.98	393	9606	446	1956	1.1	2.85	1.3	5.8	1.1	28.5	1.3	5.8

were four lots of them of six each. They were a uniform lot of good pure breds and grades. They were enclosed with hurdles and moved about whenever necessary so that the grazing was always good. The experiment proper consisted of 56 days.

Table IX gives the results of this test.

The lowest but most expensive gain was made by Lot I on alfalfa pasture and shorts. Substituting in Lot II, 1.1 pounds molasses for 1 pound shorts per animal per day increased the consumption of alfalfa considerably and the daily gain was increased .22 pounds and the cost of 100 pounds' gain was decreased from $4.99 to $3.18. Adding 5.8 pounds of skim milk to the daily ration as in Lot III still further increased the daily gain and reduced the cost of production to $2.78 per hundred. Reducing the grain in Lot IV to 1.1 pound per animal per day did not improve the ration as to gain and economy of production. The cheapest and most satisfactory gain was made by Lot III on 1.45 pounds shorts, 27.8 square feet of alfalfa pasture, 1 pound beet molasses and 5.8 pounds skim milk per animal per day. In this, as in other feeding trials, beet molasses had a high food value.

Feeding Beet Pulp to Horses.

During the winter of 1904 and 1905 a feeding experiment was carried on at the Logan factory to ascertain the value of sugar beet pulp as a food for horses. The work performed by the horses consisted of hauling feed to cattle and at times was heavy on account of bad roads. For the first six weeks eight horses were used in the experiment. The weights of the animals at the close of the test were lost, however, so only brief mention is made of the results. The horses on pulp took, on an average, 16 pounds of well fermented solid pulp per day; and 20 pounds per day was the most taken at any time. A careful observation of every animal was made daily and at no time could any irregularity in the health be attributed to the pulp. Colts have been allowed constant access to pulp at this factory for several years and not in one instance, to the knowledge of the owner, has trouble arisen from it.

In the second and third periods, of 28 days each, two teams were used in the test and pulp was fed to only one horse in each team. At the close of the second period the feed was reversed.

Table X gives the results of the test.

BEET PULP VS. NO BEET PULP FOR HORSES.

2nd Period.

TABLE X.

TEAM	NAME OF HORSES	Average Weight of Horse at Beginning of Experiment.	Average Weight of Horse at Close of Experiment.	Amount of Oats Consumed per Animal per day—Pounds.	Amount of Alfalfa Consumed per Animal per Day—Pounds.	Amount of Pulp Consumed per Animal per Day—Pounds.	Gain or Loss In Live Weight—Pounds.
Jim and Jeff	Jim	1250	1187	9.32	21	6	—63
	Jeff	1350	1310	12.4	22		—40
Frank and Bob	Frank	1120	1125	12.4	22	9.5	+5
	Bob	1344	1352	12.4	24		—8
3rd Period.							
Jim and Jeff	Jim	1165	1180	12.4	23		—15
	Jeff	1285	1330	9.32	24	11	+45
Frank and Bob	Frank	1130	1140	12.4	23.5		+10
	Bob	1365	1335	12.4	23.5	9.6	—10
Average of Combined Results.							
	Pulp	1255	1249	10.9	23	9	—6
	No Pulp	1247	1245	12.4	23		—2

The horses took to the pulp reluctantly and their appetite for it gradually decreased. The alfalfa, oats and pulp were fed in separate boxes and the horses were given only such amount of pulp as they would clean up. Any pulp left was removed and the boxes cleaned. The above results indicate that beet pulp can be fed to horses without detriment to their health, though

the amount consumed was small. The horses on pulp received 1.5 pounds less of grain per day than those that received no pulp, the amount of hay fed being the same in each case. The animals in each lot did equally well and whether or not 9 pounds pulp is equal to 1.5 pounds oats when fed as in this experiment, awaits further demonstration.

Effect of Beet Pulp on Strength of Bone.

The claim has been made that beet pulp produces a weak bone. To secure definite information on this point, two lots of wethers of three each, were fed during the winter of 1904 and 1905, one of which received 10 pounds of pulp per animal per day and the other none. The experiment extended from November 1st to March 7th. The bones of both lots of sheep, without being subjected to heat, were stripped of the meat and their strength determined in a Rhiele cement testing machine. The average strength in pounds of the principal bones of the body is given in the following table:

TABLE XI.

RATION.	Femur	Humerus	Tibia	Radius	Metacarpal	Metatarsal
Pulp	829	1019	508	666	670	761
No Pulp	714	833	488	534	440	572
Difference in favor of pulp	115	186	20	132	30	189

The results of this trial indicate that pulp does not produce a weak bone.

PART II.

Feeding Different Amounts of Grain to Dairy Cows.

How much grain to feed dairy cows for most economical production is a very important question, and the answer, in the light of present knowledge, can be only approximate at best.

Breed, habits, age, individuality, development period of lactation, kind of grain and forage fed and general care must be considered. The feed is the most important. If such foods as corn and barley are being fed with alfalfa, prices for all grain being the same, they can more profitably form a larger part of the total ration than can bran, shorts or cottonseed meal. The object of part of this bulletin is to show the effect of different amounts of grain with alfalfa for dairy cows.

To what extent can forage, similar to bran in composition, be substituted for bran, is a question that has been investigated by a few of the experiment stations. At the Tennessee station an experiment was carried out in which the following rations were compared: Silage, wheat, bran, and cottonseed meal; and silage, alfalfa hay and wheat bran. The following are some of the conclusions drawn from this experiment: "In substituting alfalfa hay for wheat bran it will be best to allow 1½ pounds of alfalfa to each pound of wheat bran; and the results are likely to prove more satisfactory if the alfalfa is fed in a finely chopped condition.

"These tests indicate that with alfalfa hay at $10.00 per ton and wheat bran at $20.00, the saving effected by substituting alfalfa for wheat bran would be $2.80 for every 100 pounds of butter and 19.8 cents for every 100 pounds of milk. The farmer could thus afford to sell his milk for 19.8 cents a hundred less than he now receives, and his butter for about 22 cents as compared with 25 cents a pound.

"These experiments show why alfalfa has been frequently used as a basis for manufactured food stuffs and indicate that the farmer who can grow it makes a mistake in purchasing artificial food stuffs of which it forms a basis."

The following is taken from New Jersey Experiment Station Bulletins Nos. 161 and 148.

"A home grown ration composed of 13 pounds of alfalfa hay and 30 pounds of corn silage, proved both practical and economical when fed in comparison with a ration in which over two-thirds of the protein was derived from wheat bran and dried brewer's grains. Milk was produced from the home grown ration for two-thirds the cost of that from the feed ration. The cost

of milk per hundred was 55.9 cents against 83.9 cents for the feed ration.

"On the basis of this experiment, when mixed hay (timothy and red top) sells for $16.00 per ton, wheat bran for $26.00 per ton, and dried brewer's grains for $20.00 per ton, alfalfa hay is worth $24.52 per ton as a substitute for mixed hay, wheat bran and dried brewer's grains fed in the proportion indicated in the ration.

"A feeding experiment showed that the protein in alfalfa hay could be successfully and profitably substituted in a ration for dairy cows for that contained in wheat bran and dried brewer's grains and for this purpose is worth $11.16 per ton, when compared with the wheat bran and dried brewer's grain at $17.00 per ton."

From these station findings one can readily understand that great value is given to alfalfa in other states in substituting it for grains of similar composition.

In Utah, bran and alfalfa hay are the foods in most common use for cows; other grains, as corn and barley, which along with alfalfa, form the most ideal ration, are high priced and not used by Utah dairymen. This is not an ideal condition for most profitable operations. The dairyman, by carefully conserving the manure, liquid and solid, and applying it to the soil, can have for his animals a large variety of foods. Along with bran and alfalfa he can have barley, oats, roots, and a mixture of grasses, all of which can be grown at a profit if the soil is enriched, well tilled and the crop properly taken care of. To secure the greatest profit good cows and intelligent treatment are as necessary as proper foods. It matters little, so long as plenty of alfalfa is given, whether or not grain is fed, when no attention is given to the quality of the cow or the care she receives.

Alfalfa hay and bran are very much the same in composition as shown by the following table taken from "Feeds and Feeding" by Henry:

	Digestible Protein %	Digestible Carbohydrates %	Digestible Fat %
Wheat bran	12.2	39.2	2.7
Alfalfa hay	11.0	39.6	1.2
One-third shorts Two-thirds bran	12.2	42.8	2.86

The grain fed in the experiments herein reported was about one-third shorts and two-thirds bran as it commonly comes from our mills. All three foods are very much the same in composition, a higher per cent of protein and fat being contained in the grains. The grain mixture contained the highest per cent of carbohydrates, namely 42.8 per cent.

The feeding in each experiment was run for two periods, the feed being reversed on the lots at the close of the first period. Individual weighings were made for several consecutive days at the beginning and at the close of each period and an average taken from them. The preliminary periods consisted of not less than two weeks. The cows were fed, milked and generally cared for at regular hours, considerable attention being given to kindness so that the milk flow would not be influenced by unfavorable conditions. The cows used in this work were about four months along in lactation and were common grade Shorthorns of fairly good milk type though carrying considerable flesh. The object of the first experiment was to ascertain the effect on live weight and milk flow of a heavy grain ration with alfalfa.

The experiment was composed of twenty-one day periods exclusive of preliminary feeding and was made during the winter of 1903 and 1904. There were three cows in each lot at the beginning of the experiment but as one of them had the habit of going dry at a certain time in lactation, her record was rejected. There was an average of five cows for two periods of three weeks each. Table XII gives the combined results of two periods with the same cows, the feed being reversed on the lots at the close of the first period.

Heavy Grain Ration vs. Light Grain Ration.

TABLE XII.

RATION	Average Weight of Cows —Pounds.	(—)Loss or (*) Increase in Live Weight per Lot —Pounds.	Average Gain per Animal per Day—Pounds.	Total Milk Produced—Pounds.	Total Fat Produced—Pounds.	Milk Produced per Cow per Day—Pounds.	Fat Produced per Cow per Day—Pounds.	Cost of 100 Lbs. Milk —Cents.	Cost of 1 Lb. Butter Fat—Cents.	Total Food Consumed—Pounds		Food Required For 100 Lbs. Milk—Pounds		Food Consumed per Animal, Day	
										Alfalfa.	Grain.	Alfalfa.	Grain.	Alfalfa.	Grain.
Heavy Grain.....	1186	*124	1.1	1923	85.4	18.3	.81	83	18.7	1322	1592	68	83	12	15
Light Grain.....	1171	* 54	.5	1859	76.5	17.7	.73	53	13.0	2663	416	143	22	25	4

The average weight of cows in this experiment was 1,178 pounds, there being practically no difference in the weights of the cows of the different lots. A daily consumption of 25 pounds of alfalfa hay and 4 pounds of grain (⅓ shorts and ⅔ bran) produced 17.7 pounds of milk and a daily gain in live weight per head of ½ pound. The food cost of 100 pounds of milk was 53 cents and of 1 pound of butter fat 13 cents. With the heavy grain ration a daily consumption of 12 pounds of alfalfa hay and 15 pounds of grain produced 18.3 pounds of milk and a daily gain in live weight per head of 1.1 pounds. The food cost of 100 pounds of milk was 83 cents and of 1 pound of butter fat 18.7 cents. The cows were given all the alfalfa hay they would eat and in daily consumption an increase of 11 pounds of grain per head caused a decrease of 13 pounds in the amount of alfalfa hay consumed and a daily increase in milk of only .6 pound. In the production of 100 pounds milk, 61 pounds of grain saved 75 pounds alfalfa hay.

The amount of milk produced the second period by the cows on light grain ration was 90 per cent of the amount produced by the same cows the first period on heavy grain ration, while the amount of milk produced the second period by the cows on heavy grain ration was 93 per cent of the amount produced by the same cows the first period on light grain ration.

In the winter of 1904 and 1905, 8 pounds of grain was fed per animal per day to one lot of cows, and 4 pounds of grain per animal per day to another lot. There were three cows in each lot and the periods consisted of five weeks, with preliminary periods of two weeks. The cows were cared for, weighed and the feed reversed at the close of the first period, the same as in the first experiment conducted the year before. The cows on an average were two months along in lactation.

Table XIII gives the combined results of the two periods:

A daily consumption of 23 pounds of alfalfa and 8 pounds of grain produced 22.6 pounds of milk and a daily gain in live weight of .2 pounds. The food cost of 100 pounds of milk was 53 cents and of 1 pound of butter fat 12.9 cents.

A daily consumption of 26 pounds of alfalfa and 4 pounds of grain produced 22.5 pounds of milk and with it there was a de-

Medium Grain Ration vs. Light Grain Ration.

TABLE XIII.

RATION	Average Weight of Cow —Pounds	(—)Loss or (*) Increase in Live Weight per Lot —Pounds.	Average Gain or Loss per Animal per Day—Pounds.	Total Milk Produced —Pounds.	Total Fat Produced —Pounds.	Milk Produced per Cow per Day—Pounds.	Fat Produced per Cow per Day—Pounds.	Cost of 100 Lbs. Milk —Cents.	Cost of 1 Lb. Butter Fat—Cents.	Total Food Consumed Pounds		Food Required for 100 lbs. Milk Pounds		Food Consumed per Animal per Day--Lbs.	
										Alfalfa.	Grain.	Alfalfa.	Grain.	Alfalfa.	Grain.
Medium Grain.....	1038	* 45	*.2	4758	197.3	22.6	.93	53	12.9	4853	1680	102	35.3	23.1	8
Light Grain.....	1035	— 80	—38	4738	179.6	22.5	.85	43	11.3	5428	840	114	17.7	26.3	4

crease in live weight of .4 pounds. The food cost of 100 pounds of milk was 43 cents and of 1 pound of butter fat 11.3 cents.

In daily consumption an increase of 4 pounds of grain saved 3.2 pounds of alfalfa hay with practically no increase in the amount of milk produced. In the production of 100 pounds of milk 17.6 pounds grain saved only 12 pounds of alfalfa hay.

In the change from 8 pounds of grain per animal per day the first period to 4 pounds per day the second period, there was a decrease in milk flow of 10.3 per cent. In the change from 4 pounds of grain per animal per day of the first period, to 8 pounds of grain per animal per day the second period, there was a decrease in milk flow of only 7.9 per cent. The milk flow was maintained better on the larger than on the smaller amount of grain.

During the winter of 1905 and 1906 the above experiment with grain was repeated. There were six cows in each lot and the feeding periods consisted of eight weeks each with two weeks of preliminary feeding. The experiment was planned a year in advance so that the cows were all in good condition when it began. The feed was reversed at the close of the first period.

Table XIV gives the combined results of the two periods of this trial.

In this trial, as in the preceding ones, 4 pounds of grain per animal per day gave cheaper production than 8 pounds of grain. With 4 pounds of grain the food cost of 100 pounds of milk and 1 pound of butter fat was 47 cents and 12.4 cents respectively, while with 8 pounds of grain it was 57 cents and 15 cents respectively. The cows on 8 pounds of grain a day made a daily gain of .4 pound each, while those on 4 pounds of grain a day made no gain. The milk from cows on 8 pounds of grain a day was a little higher in butter fat than the milk from cows on 4 pounds of grain. The amount of milk produced the second period by the lot on 8 pounds of grain was 86.5 per cent of the amount produced by the same lot the first period on 4 pounds grain, while the amount produced the second period on 4 pounds grain was only 74.8 per cent of the amount produced by the same lot the first period on 8 pounds grain. This is a difference of 11.7 per cent in favor of the medium grain ration.

TABLE XIV.

RATION	Average Weight of Cows—Pounds.	(—)Loss or (*) Increase in Live Weight per Lot—Pounds.	Average Gain or Loss per Animal per Day—Pounds.	Total Milk Produced—Pounds.	Total Fat Produced—Pounds.	Milk Produced per Cow per Day—Pounds.	Fat Produced per Cow per day—Pounds.	Cost of 100 Lbs. Milk—Cents.	Cost of 1 Lb. Butter Fat—Pounds.	Per Cent Fat in Milk.	Total Food Consumed—Pounds			Food Required for 100 lbs. Milk Pounds			Food Consumed per Animal per Day—Lbs.		
											Alfalfa.	Grass Hay.	Grain.	Alfalfa.	Grass Hay.	Grain.	Alfalfa.	Grass Hay.	Grain.
Light Grain..	1046	—33		14,395	544.2	21.4	.81	47	12.4	3.87	11,518	6581	2688	80.	45.7	18.6	17.1	9.8	4
Medium Grain	1050	*3.20	*.4	15,641	594.2	23.2	.88	57	15.0	3.89	11,167	6803	5376	71.3	43.4	34.3	16.6	10.	8

TABLE XV.

RATION	Number Pigs in Lot.	Average Weight at Beginning of Experiment—Pounds.	Average Weight at Close of Experiment—Pounds.	Average Gain per Pig per Day—Pounds.	Total Gain—Pounds	Total Food Consumed—Pounds.				Food Consumed per Pound Gain—Pounds.			Food Consumed per Pig per Day—Pounds.		
						Shorts.	Skim Milk.	Apples.	Pasture Days.	Shorts	Skim Milk.	Apples.	Shorts.	Skim Milk.	Apples.
Apples	3	64	155.7	1.6	275	572	1148	1122	..	2.08	4.17	4.08	3.4	6.8	6.6
No Apples.....	3	65.3	175	1.9	328	838	1148	....	..	2.55	3.5	....	4.98	6.8	....
Apples	5	115.2	200	1.5	424	911	887	3720	..	2.2	2.1	8.77	3.25	3.1	13.2
No Apples.....	5	113.4	168.3	.98	275	911	887	....	..	3.3	3.2	....	3.25	3.1	....
Apples*	3	59.4	92.7	.59	99.5	286.5	....	646	..	2.8	....	6.4	1.7	...	3.8
Pasture*	3	58.4	90.2	.56	95.2	286.5	....	....	56	3.0	....	....	1.7	...	....

*Average of two lots of three pigs each.

Apples as a Food for Swine.

The apple crop of Utah is rapidly increasing in commercial importance and with each year large areas are being planted to trees. There are always more or less apples for which there is no market and at times a large amount of them is fed to live stock on the farm. To ascertain their value as food for swine, experiments covering three years were started in the autumn of 1904.

This work for the first two years consisted of comparing grain, skim milk and apples with grain and skim milk, while the last year it consisted of comparing grain and apples with grain and pasture. The feeding period proper of all trials consisted of 56 days.

Table XV gives the results of these trials.

In the first trial during the fall of 1904, with pigs weighing 64 and 65 pounds each, 1,122 pounds apples saved 266 pounds grain, but produced 53 pounds less gain.

In the second trial with pigs weighing 115 pounds each, 3,720 pounds apples produced 149 pounds gain.

According to these trials if pork is worth 4½ cents live weight, skim milk 15 cents per cwt., and grain $20.00 per ton, as was the case in this instance, apples would have a value of from nothing to 18 cents per hundred.

In the third trial with pigs weighing about 60 pounds each, apples were about equal to grass pasture. The pigs in this test received no skim milk and therefore did not make as large gains as did pigs receiving skim milk in the first trials.

Grazing Experiment With Swine.

During the summer of 1905 investigations were started to compare the grazing qualities of pure-bred Tamworth, Yorkshire, Berkshire, Poland China, and Tamworth grades. The bacon type was well represented by pure-bred Tamworth and Yorkshire, and the lard type by Berkshire and Poland China grades. There were six pigs in each lot the first year and five the second year.

The following table gives the combined results of the two years' tests extending an average length of 107 days:

TABLE XVI.

BREED.	Gain per Pig per Day—Pounds.	Shorts Consumed per 1 Pound Gain.	Skim Milk Consumed per 1 Pound Gain.	Cost of 1 Pound Gain Exclusive of Alfalfa.	Average Weight of Pigs at Beginning of Experiment.	Average Weight of Pigs at Close of Experiment.
Tamworth	.78	2.31	6.7	$3.31	53.6	140.6
Yorkshire	.7	2.52	8.17	3.75	48.1	126.2
Berkshire and Poland China Grades.....	.74	2.46	7.1	3.52	56.	137.7
Tamworth Grades	.73	2.46	6.65	3.45	56.8	137.8

Pure-bred Tamworths gave the largest gains at the least cost, while pure-bred Yorkshires gave the smallest gains at the greatest cost. Notwithstanding the fact that the Tamworths were the youngest and were the lightest in weight when the experiment began in the first trial, they led in both gain and cost of production. In the second trial the pure-bred and grade Tamworths were equal in gain and cost of production, but the grades were older and were heavier in weight when the experiment began.

At the close of the grazing experiment the first year, all lots were put in pens and fed grain, skim milk and sugar beets, exclusive of preliminary period, for 57 days. In this the pure-bred Tamworths were first in gain and third in economy of production; the Tamworth grades second in gain and first in economy of production; Poland China and Berkshire grades third in gain and second in economy of production, and pure-bred Yorkshires fourth in gain and fourth in economy of production.

In the three experiments, two grazing and one in bare pen, the Tamworth grades on an average were but little ahead of the Berkshire and Poland China grades. The pure-bred Yorkshires in these trials as well as in the maintenance work, in which alfalfa hay formed a large part of the ration, were not the equal of the other breeds. They did not prove to be robust, vigorous feeders.

The raising of swine in Utah has never received the attention from the farmers that its importance demands, presumably because little is known of the cost of production. A great many feeding experiments have been carried on at this station from time to time, but no records have been kept of what it costs to produce pork in its various stages, including the cost of the keep of the sow. In securing the figures in the following table the animals were fed various products of the farm, some of which could not be utilized in any other way. In every instance the sows and pigs had the run of a grass paddock if not of an alfalfa field. The aim was to so regulate the feed as to keep the sows in a good thrifty condition and the pigs growing from birth until disposed of.

Spring Litters.

TABLE XVII.

Food Consumed when Not Suckling Pigs—Pounds.

Ear Tag Number of Sow.	Shorts.	Skim Milk.	Whey.	Beet Pulp.	Sugar Beets.	Alfalfa Hay.	Potatoes.	Pasture Days.
69	737	497	358	261	153	280	93	
70	629	594	387	230	153	190	93	
72	536	364	237	230	189	189	43	
1301	611	609	496	140	290	204	17	
1302	350	1047	168	63	310	569	77	97
177	92	607	286	...	...	847	..	111

Fall Litters.

1301								
1302								
177								

Spring Litters.

Food Consumed while Suckling Pigs—Pounds.

Ear Tag Number of Sow	Shorts.	Skim Milk.	Whey.	Alfalfa Hay.	Beet Pulp.	Sugar Beets.
69	126	395	...	...	...	...
70	520	185	612	...	...	...
72	412	367	371	...	...	...
1301	72	301	...	...	...	...
1302	164	359	...	137	18	...
177	170	590	...	34	...	...

Fall Litters.

1301	315	592	...	...	...	25
1302	347	994	...	196	...	584
177	125	748	...	111	...	...

Spring Litters.

Food Consumed by Pigs After Weaning Until Disposed of—Pounds.

Ear Tag Number of Sow	Shorts.	Skim Milk.	Beet Molasses.	Whey.	Beet Pulp.	Sugar Beets.	Alfalfa Hay.
69	1972	2576	391	443	2594	...	...
70	1636	2088	...	...	2380	...	...
72	1465	2573	...	...	2138	...	...
1301							
1302							
177							

Fall Litters.

1301	2006	9876	...	...	748	522	581
1302	2510	6422	...	145	....	347	1047
177	1386	4701	...	110	....	...	688

Spring Litters.

Ear Tag Number of Sow	Number of Pigs in Litter That Were Raised.	Weight of Litter at Farrowing Time—Pounds.	Weight of Litter at Weaning Time—Pounds	Weight of Litter When Disposed of—Pounds.	Age of Pigs When Weaned—Days.	Loss of Live Weight of Sow While Nursing Pigs.
69	6	16	122	955	41	55
70	7	17	283	915	78	10
72	5	13½	216	810	79	14
1301	4	25	86	...	53	37
1302	7	27	245	...	51	207
177	1	22	37½	...	66	35

Fall Litters.

1301	9	28	185	1156	45	*35
1302	7	17½	208	1353	55	
177	5	15½	94	756	38	*15

The average total cost, including feed of sow per year per litter of five or six pigs to weaning time, was $10.47. The average age and weight per pig at weaning time of one litter per year dropped in the spring was 61 days and 32.6 pounds, respectively. The average cost of spring litters of six pigs each including the cost of the keep of the sow for one year, when disposed of at a weight of 893 pounds, was $29.42. The average cost of fall litters of seven pigs each, including the cost of the keep of the sow for one year, when disposed of at a weight of 1,088 pounds, was $36.90. The cost per cwt. for spring pigs from weaning to a weight of 150 pounds was $2.70 and of fall pigs fed through the winter to a weight of 133 pounds, $2.77. The summer pasture was largely replaced by alfalfa hay in the winter. No account is made of the pasture. All of the sows were turned from field to field at times and considerable grazing secured that otherwise would have been wasted. The potatoes fed were worthless for any other purpose and many of the beets and much of the pulp could not have been utilized in any other way. In calculating cost, market value was put on these as near as could be ascertained. A considerable quantity of shorts was purchased, a price of $16.00 per ton being secured, which is less than they can be purchased for in small amounts. Using the above results, any price for foods can be used and the cost of production in any locality ascertained.

Cost of Raising Cattle to Two Years of Age.

As part of the plans of the work in Animal Industry extending over a period of years, the cost of raising calves up to two years was secured and is here given. The calves were largely grade Shorthorns, Guernseys and Holsteins. They were allowed to nurse their dams but a few times, after which they were hand fed. The table below gives the foods used.

The cost was calculated on the following prices of foodstuffs:

Whole milk	$ 1.00 per hundred
Skim milk	.15 per hundred
Roots	4.50 per ton
Alfalfa hay	5.00 per ton
Grain	16.00 per ton
Pasture	1.50 per month

TABLE XVIII.

NO.	Weight at Birth.	Weight at 2 Years of Age.	Food Consumed First Year—Pounds.					Food Consumed Second Year—Pounds.			
			Whole Milk.	Skim Milk.	Alfalfa Hay.	Grain.	Roots.	Grain.	Alfalfa Hay.	Roots.	Pasture Days.
1	78	1043	277	3637	2554	711	671	...	3667	...	181
2	90	1083	507	1890	1571	942	1320	303	3023	...	195
3	92	1250	326	2487	1259	724	873	413	2604	445	195
4	67	1070	441	3919	1243	430	....	302	2823	...	185
5	77	875	1305	1668	1112	335	....	290	2524	...	182
6	43	830	757	3916	1306	428	....	302	2270	...	183
7	71	1055	411	3202	1153	332	....	302	2886	...	183
8	..	949	959	4117	1309	358	284	...	3348	...	184
9	75	1168	434	3806	1869	....	822	...	2890	...	176
10	79	1060	506	3394	1527	....	822	...	3390	...	173
11	76	985	226	1680	2076	551	880	...	4028	...	185
12	93	1075	296	1544	2107	577	880	...	3931	...	180

The average weight at birth was 76.4 pounds and at two years of age 1,037 pounds. The average cost of keep with twelve head the first year was $19.00 and the second year $17.97. The total cost of keep to two years of age was $36.97. Eight of the heifers averaged two years and two months old when they commenced to milk. By reducing the amount of whole milk consumed, the cost of production the first year will be reduced. To feed a minimum of whole milk and keep the calves in a thrifty condition the change to skim milk must be made carefully.

In the fall of 1903 an experiment, to run for a number of years, was begun to determine whether or not sheep can be profitably kept on the enclosed farm. The foundation flock consisted of fifteen low-grade one-year-old Cotswold ewes. These ewes averaged 90 pounds each and cost $3.10 per head. The flock was gradually enlarged the second and third years by the addition of a few pure-bred Rambouillet ewes and by the natural increase in lambs. These sheep were run on pasture which was supplemented with alfalfa hay whenever necessary. The feed the first winter consisted of alfalfa hay, grain and a small amount of roots; the second winter of hay and grain, and the third winter of hay only, no grain being fed until after the lambs were dropped. A creep was provided and the lambs got grain by themselves as soon as they would take it. The pasture was bench land underlaid with gravel and could not always be kept in good condition during mid-summer on account of a shortage of water. To protect from dogs the sheep were housed nights during the whole year.

The following is a financial statement of the operation by years:

YEAR 1904.

COST.

15 ewes	$46.50
8,041 pounds of alfalfa@$5.00 per ton	20.10
1,648 pounds of grain@$16.00 per ton	13.18
2,595 pounds of roots@$4.50 per ton	5.83
1.7 acres of pasture@$7.67 (rent for grazing)	13.04
Total	$98.65

RETURNS.

15 ewes	$46.50
122 pounds of wool@13c	15.86
1,037 pounds of lambs@3½ cents	36.29
Total	$98.65

YEAR 1905.

COST.

35 ewes (25 valued@$4.00, and 10@$3.50)	$135.00
30,254 pounds of alfalfa@$5.00 per ton	75.76
3,796 pounds of grain@$16.00 per ton	30.36
2.8 acres of pasture@$14.77 (rent for grazing)	41.36
Total	$282.48

RETURNS.

34 ewes (one died during year)	$131.00
345 pounds of wool@20c	69.00
1,833 pounds of lambs@4½c	82.48
Total	$282.48

YEAR 1906.—(Eleven Months.)

COST.

34 ewes	$136.00
28,101 pounds alfalfa@$5.00 per ton	70.25
2,437 pounds of grain@$16.00 per ton	19.49
3 acres of pasture@$21.91 (rent for grazing)	65.72
Total	$291.46

RETURNS.

33 ewes (one died during year)	$132.00
377.3 pounds of wool@21c	79.23
1,783 pounds of lambs@4½c	80.23
Total	$291.46

In the spring of 1906 ten lambs with a total weight of 357.5 pounds died from the effects of castration. No account is made of this loss in the returns. The returns for the year 1906 are the highest of any year, no grain being fed until lambing time and a higher price received for the wool. This year's work consisted of only eleven months. Had the feed required for another month been included the profit would not have been as great.

In calculating the results of these three years' work with sheep, deterioration (due to advanced age of some of the ewes) was not considered as this would be offset by the increased value of the lambs that were yearly added.

SUMMARY:

(1) Sugar beets and beet pulp for dairy cows are nearly equal in value.

(2) Sugar beets and beet pulp had a value of from 90 cents to $1.00 per ton.

(3) Milk from beet and pulp-fed cows was a trifle higher in butter fat, the increased percentage being very small.

(4) Milk flow and daily yield of butter fat were maintained as well without beets and pulp as with them.

(5) In feeding 1,000-pound steers all the alfalfa and beet pulp they would take, larger and more economical gains were secured by adding 4 pounds grain to the ration per steer per day.

(6) In a ration of alfalfa and pulp with steers, limiting the pulp one-fourth to one-half with all the alfalfa that they would take, increased the gains and reduced the cost of production.

(7) In a ration of alfalfa and pulp with steers, limiting the alfalfa one-half, with all the pulp that they would take, increased the cost of production and decreased the gains.

(8) In feeding 80-pound wether lambs all the alfalfa and pulp they would take, 1 pound of grain added to the ration per lamb per day, increased the gain and also the cost of production.

(9) One-half pound of grain per lamb per day compared with 1 pound of grain gave lower gains and also lower cost of production.

(10) One-half pound of grain per lamb per day, with all the alfalfa and pulp that the animal would take, compared with no grain, increased the cost of production but not the gain.

(11) In a ration of alfalfa and pulp with lambs, limiting the pulp one-fourth to one-half with all the alfalfa that they would take, increased the gain and decreased the cost of production.

(12) In a ration of alfalfa and pulp with lambs, limiting the alfalfa one-half, with all the pulp that they would take, increased the gains and decreased the cost of production.

(13) In feeding a ration of alfalfa and beet pulp to sheep and steers better results were secured in every instance when either the alfalfa or the pulp was limited. Larger gains and cheaper production were secured when the pulp rather than the alfalfa was limited.

(14) Sugar beets fed to steers with alfalfa and 4 pounds grain per head per day, had a value of $2.36 per ton.

(15) Sugar beets fed to eight months old lambs, with alfalfa and 5 pounds grain per head per day, had an average value of $3.41 per ton.

(16) Beet molasses fed to pigs, with green alfalfa, skim milk and shorts, had a value of $1.12 per hundred.

(17) Beet molasses fed to pigs, with shorts and beet pulp, had a value of 84 cents per hundred.

(18) By substituting 1.1 pounds molasses for 1 pound shorts with pigs fed shorts and on alfalfa pasture, the consumption of the latter was increased, the daily gain per pig increased from .5 pound to .72 pound and the cost of production per hundred reduced from $4.99 to $3.18. By further adding 6 pounds skim milk per pig per day to the ration, the daily gain was increased to 1.13 pounds, and the cost of production per hundred reduced to $2.78.

(19) For swine, sugar beets had an average value of $3.52 and pulp $2.57 per ton.

(20) As high as 20 pounds of pulp was fed to horses per animal per day without any apparent injury. In a ration of alfalfa hay and oats 9 pounds of well fermented solid pulp saved 1.5 pounds oats.

(21) Pulp fed to sheep did not produce a weak bone.

(22) In feeding dairy cows a basal ration of 4 pounds of grain (⅓ shorts, ⅔ bran) and twelve pounds hay, 13 pounds good alfalfa hay fed along with it was nearly equal in value to 11 pounds of grain. Thirteen pounds of alfalfa, fed in connection with the basal ration, produced .6 pound of milk and .08 pound of butter fat per cow per day less than did 11 pounds grain when so fed, but the cost of 100 pounds of milk was reduced 30 cents and of butter fat 5.7 cents.

(23) In feeding alfalfa to cows, milk and butter fat were produced cheaper on 4 pounds of grain per cow per day than on 8 pounds. The daily yield of milk and fat was increased by the larger amount of grain, .95 and .07 pound, respectively. The milk flow was maintained better on the larger than on the smaller amount of grain.

(24) Apples fed to pigs in two experiments with skim milk and shorts had a value from nothing to 18 cents per hundred. In one experiment apples were only equal to grass pasture.

(25) As grazers, pure-bred Tamworth swine were most superior. Berkshire, Poland China and Tamworth grades were about equal. Pure-bred Yorkshires were not equal to the other breeds in feeding qualities, especially as grazers.

(26) The average cost of spring litters of six pigs each, including the cost of the keep of the sow for one year, when disposed of at a weight of 893 pounds, was $29.42. The average cost of fall litters of seven pigs each, including the cost of the keep of the sow for one year when disposed of at a weight of 1,088 pounds, was $36.90. The cost per hundred for spring pigs from weaning to a weight of 150 pounds was $2.70, and of fall pigs fed through the winter to a weight of 135 pounds, was $2.77.

(27) The average cost of raising cattle to one year of age was $19.00 per head, and to two years of age, at which time they averaged 1,037 pounds in weight, was $36.97.

(28) Sheep can be kept on irrigated farms at a good profit when hay sells for $5.00 per ton, grain $16.00 per ton, and wool and mutton at 20 and 4½ cents per pound respectively. At these prices there was greater profit in pasturing the land with sheep than in raising alfalfa and selling it.